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PREDICTING SUCCESS IN TENTH GRADE GEOMETRY

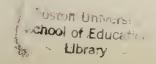
Submitted by

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In partial fulfillment of requirements for the degree of Master of Education

1947

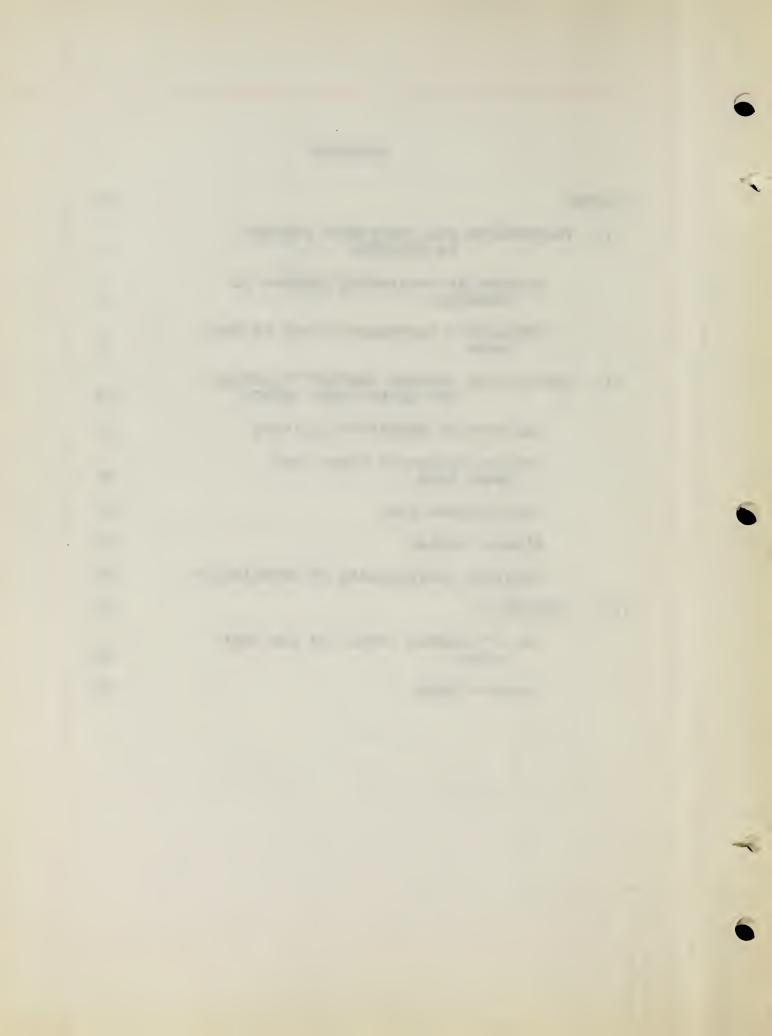
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CHAPTER I

INSTRUMENTS FOR PREDICTING SUCCESS IN GEOMETRY

Value of prognosis:— In some high schools plane geometry is still a required tenth-grade subject for all pupils enrolled in the college course. Many of these pupils fail. Of the 113 pupils in this paper, 40 pupils, or 35.4 per cent, failed the first semester of tenth-grade plane geometry. Of the 73 pupils who passed, eight were repeating geometry. Disregarding these eight the percentage of failures increases to 38.1. If it can be determined in advance that certain pupils will very probably fail, these pupils can be spared a half year or full year of wasted time, a sense of failure, no increase in mental growth, and loss of credits needed for graduation. These same pupils in September can be guided toward subjects which their ability and interest will enable them to study profitably.

Such determination in advance can also prove of advantage to pupils who show probability of passing but whose subsequent work is failing. Further investigation may trace such failure to physical defects, reading difficulty, poor study methods, or poor teaching methods.

Pupils enrolled in courses other than the college course have no opportunity to study mathematics other than commercial arithmetic. Just recently college-course pupils have been allowed to invade the commercial field especially to study typewriting and stenography. It may be that there are pupils in the commercial course who are not achieving their maximum mental growth because they are deprived of an opportunity to study subjects restricted to college-course pupils. If a method can be devised to foretell probable success or failure in geometry, interested pupils who show high probability of success may be allowed to take geometry in addition to the commercial subjects.

Previous records and pre-geometry tests as predictive instruments. — In Kelley, Educational Guidance, the following sources for predicting success in English, mathematics, and history were used: the grammar-school record; age; previous teachers' estimates of intellectual ability, conscientiousness, emotional interest in the work, oral expression; and grades in tests given at the beginning of the year in mental capacity, preparation for the particular course, and effort and interest in the subject.

1/ Truman Lee Kelley, Educational Guidance — Teachers

College Contributions to Education, No. 71. Teachers College, Columbia University, New York, 1914, vi + 116 p.

It was found that of these the grammar-school record is
the most reliable and age is the least reliable. The
grammar-school record, however, was correlated with ninthgrade marks only. The coefficient of correlation between
previous teachers' estimates and mathematics schievement
was .61; between all the initial tests and geometry
achievement, .44; and between the interest tests and
mathematics achievement, .30.

In Rogers, Experimental Tests of Mathematical

Ability and Their Prognostic Value, 17 tests were administered to 114 girls - tests of algebraic abilities,
skill in arithmetic problems, reasoning ability, geometric abilities, and language abilities. It was found that these tests foretell how well a pupil will do in geometry about three fourths as accurately as does his ninth-grade record in algebra. Again age was found not to be a reliable factor for prognosis in geometry.

In Lee and Lee, 2/ "Some Relationships Between Algebra and Geometry," it was found that the coefficient of correlation between scores on Lee Test of Algebraic Ability and

^{1/} Agnes Low Rogers, Experimental Tests of Mathematical Ability and Their Prognostic Value - Teachers College Contributions to Education No. 89. Teachers College, Columbia University, New York, 1918, v + 118 p.

^{2/} Dorris May Lee, and J. Murray Lee, "Some Relationships Between Algebra and Geometry" Journal of Educational Psychology (October, 1931) 22: 351-560.

scores on Lee Test of Geometric Aptitude was .60 \(^2\) .04; between teachers' marks in algebra and teachers' marks in geometry, 474 \(^2\) .044; and between scores on an unstandardized algebraic achievement test and scores on the Renfrow Geometry Test, .410 \(^2\) .048. Lee and Lee also quoted from previous studies the following coefficients of correlation between teachers' marks in algebra and teachers' marks in geometry: Burris found it to be .57; Crathorne, .52 \(^2\) .02; and Winegardner, .509 \(^2\) .024.

In Cooke and Fields, "The Relation of Arithmetical Ability to Achievement in Algebra and Geometry," it was found that arithmetical ability does not correlate highly with achievement in geometry.

In Cooke and Pearson, Predicting Achievement in Plane Geometry, it was found that the Orleans Geometry Prognosis Test is not appreciably more accurate in predicting than the Terman Group Test of Mental Ability, or than the teachers' algebra marks. The coefficient of correlation between teachers' algebra marks and teachers' geometry marks was .388 for Group 1 and .546 for Group 2.

^{1/} Dennis H. Cooke, and Carl L. Fields, "The Relation of Arithmetical Ability to Achievement in Algebra and Geometry," Peabody Journal of Education (May, 1932) 9: 355-361.

^{2/} Dennie H. Cooke, and John M. Pearson, "Predicting Achievement in Plane Geometry," School Science and Mathematics (November, 1933) 33: 872-878.

The coefficient of multiple correlation between a combination of the three predictive instruments and teachers' geometry marks was .436 for Group 1 and .625 for Group 2. The coefficient of multiple correlation between a combination of the three predictive instruments and scores in the Columbia Research Bureau Plane Geometry Test Form A was .747.

In Orleans, A Study of Prognosis of Probable
Success in Algebra and in Geometry, the writer outlined
the method used to construct a test to measure specific
aptitude for geometry. The coefficient of correlation between the prognostic test scores and geometry marks was
higher than between I.Q.s and geometry marks. The coefficient of multiple correlation between a combination of
prognostic test scores and I.Q.s and geometry marks was
slightly higher. Orleans also quoted from previous studies
the following coefficients of correlation between I.Q.s
and teachers marks in geometry: Brooks found it to be .51;
Todd, .33.

In Lee and Hughes, 2/ "Predicting Success in Algebra and Geometry," the correlation of a combination of the

Joseph B. Orleans, "A Study of Prognosis of Probable Success in Algebra and in Geometry," The Mathematics Teacher (April and May, 1934) 27: 165-180, 225-246.

^{2/} J. Murray Lee, and W. Hardin Hughes, "Predicting Success in Algebra and Geometry," The School Review (March, 1934) 42: 188-196.

(E The second secon

scores on the Hughes Trait Rating Scale and I.Q.s with teachers' geometry marks yielded a coefficient of .57; a combination of scores on the Lee Test of Geometric Aptitude and I.Q.s with teachers' geometry marks yielded a coefficient of .66; and a combination of scores on Trait Rating Scale and Geometric Aptitude Test with teachers' geometry marks yielded a coefficient of .67. The coefficients of correlation between a single one of these predictive instruments and teachers' geometry marks were all appreciably lower than .57.

In Richardson, Predicting Achievement in Plane
Geometry, rades in each of eight instruments of predicting success in geometry were correlated with teachers
marks in geometry for 135 pupils:

teachers' estimates of ability to do geometry
Orleans Geometry Prognostic Test
Research Office Prognostic Test
first semester algebra marks
Iowa Algebra Prognostic Test
Terman I.Q.
teachers' ratings on studiousness

.702 - .030
.672 - .032
.672 - .032
.669 - .032
.637 - .034
.625 - .035
.504 - .043
.501 - .043
.501 - .043
.502

In Hummer, 2/ "A Comparison of I.Q. and Achievement in Plane Geometry," the coefficient of correlation between scores on the Otis Group Intelligence Scale, Advanced

^{1/} H. D. Richardson, "Predicting Achievement in Plane Geometry," The Nathematics Teacher (May, 1935) 28: 310-319.

In Plane Geometry, "School Science and Mathematics (May, 1936) 36: 496-501.

Examination, Form A, and scores on the Columbia Research Bureau Plane Geometry Test (minus the sixth part geometry score) was .53 - .039. The conclusion reached in this study was that failure in geometry is likely to occur if the I.Q. is below a range level between 100 and 110.

In Hamilton. WA Method for Reducing Failures in Plane Geometry. " a point-average of minth-grade algebra and English marks (mark A equivalent to 4.00 points) was compared with first-semester geometry mark in 1934 and 1935. The pupils beginning geometry in 1935 were advised of the 1934 conclusions. After both years the decision was: the pupils with point-average over 2.00 are capable of passing geometry, pupils with point-average of 2.00 have an even chance of passing or failing, pupils with point-average below 2.00 will not pass geometry. Two facts of interest might be noted. Although in 1934 of 13 pupils with pointaverage of 2.00, six failed; in 1935 of 12 pupils with point-average of 2.00, none failed. Perhaps the awareness of their danger contributed to their improvement. Hamilton states that during the depression years he was primarily interested in a predictive instrument that would not increase the tax-payers' burden.

^{1/} J. Landon Hamilton, "A Method for Reducing Failures in Plane Geometry," Journal of Educational Research (May, 1937) 30: 700-702.

Previous records and intelligence quotients useful for prognosis. — Table 1 indicates which instruments the ten studies here summarized have found to be of definite value in predicting probable success in geometry.

Table 1. Number of Studies Advocating Each Fredictive Instrument

Predictive Instrument	Number of Studies
Ninth-Grade Algebra Hark Intelligence Test	4 3
Ninth-Grade English Mark Grammar-School Record	1

Two found age of no predictive value and one found arithmetic mark of no predictive value.

Algebra marks and intelligence quotients correlated with geometry marks. — In this paper the ninth-grade elgebra mark and the I.Q. have been correlated with the teachers' mark in first-semester geometry and with the test mark in first-semester geometry to determine their value in predicting probable success in tenth-grade geometry.

The test used to measure achievement at the end of the first semester covered the material in Book I. As no

material in a time limit which coincided with the length of the school periods, the teacher constructed a test, which coincided with the length of the school periods, the teacher constructed a test, where the school periods is a constructed a test, where the school periods is a constructed a test, which is the coefficient of correlation between the scores on part I and scores on part II is .72 \(^{+} \).03.

The test marks and the teacher's semester marks for 85 pupils, distributed as in Table 2, have been correlated. Sixteen pupils were transferred to another teacher and twelve were absent on the days of the test; these 28 took different achievement tests.

The coefficient of correlation between the test marks and the teacher's marks is .78 \(\frac{1}{2} \). O3. This is far from perfect correlation but it is not unusual to find a difference between the two measures of achievement. Neither the test mark nor the teacher's mark is a perfect measure. The test may not be a fair test of the material taught, or it may test on material imperfectly taught and therefore inadequately learned. The teacher's marks are occasionally colored by proximity to line between passing and failing, pupil's effort, pupil's health, pupil's unusual home conditions.

^{1/} See appendix, pp. 39-41.

^{2/} Ibid, p. 44.

^{3/} Ibid, p. 45.

which is the better measure of achievement is a debatable question. In the school in which this study was made, the custom is to consider the achievement-test mark as one fourth of the teachers' mark for the semester.

Abilities required to pass geometry .-- Another me thod

Table 2. Distribution of Achievement-Test Scores and Teacher's Geometry Marks for 85 Pupils

					T	e rm	Ter	at		Charles Contra	kantija er ester a gelantina dissifi den till like eginne fra år everst parti och delagn
Teacher's Marks	09	10	20 29	30 39	40	50 59	60	70 79	80 89	90 99	Total
1	2	3	4	3	6	7	8	9	10	11	12
91-97 84-90 77-83 70-76 63-69 56-62 49-55 42-48 35-41 28-34 21-27	1	2	114311	1 2 1 2 3 1	1 26 2	1 951	1 4	2 1 4 2	1 4 3 3	1 2 1	2 7 8 10 21 14 11 5 4 1
Total	2	3	11	10	11	17	6	9	11	5	85

for predicting success in geometry is to analyze the content of the course to determine if possible the specific abilities needed in addition to general intelligence to pass geometry. In an intelligence test the specific abilities are obscured in the final I.Q. Tests on these

abilities have been formulated to be given to pupils before they begin to study geometry. The mark on such a prognostic test is considered an indication of the pupil's preparedness for geometry and probable success.

Algebra with particular stress on ratio and proportion, arithmetic, and English with stress on reading with comprehension have been considered necessary preparation for studying geometry.

Some teachers feel that unless a pupil has already developed slight reasoning ability, the possibility of his success in geometry is small. In the opinion of these teachers pupils should be able to:

apply a general principle to a particular problem analyze data to find the general principle applicable to the situation select relevant features in problem solving see likenesses and differences arrange facts in proper order understand the principle of converses deduce if this is true, then that is true.

All of these reasoning abilities are used in the mastery of geometric theorems and originals.

The ability to visualize and understand spatial relationships may be indicative of a pupil's future success in geometry. Tests may be administered to determine the pupil's ability to:

hold a geometric figure in mind understand references to a geometric figure study a geometric figure infer from spatial data

im re geometric movements understand the principle of symmetry.

Another method used in prognostic tests is to present some geometric facts and require the pupils to assimilate and use them immediately to do elementary problems in geometry. Their method of doing such tasks as these:

apply the axioms to geometry
master geometric vocabulary
decide and express geometrically the "given" and
"to prove"
solve problems demanding common sense interpretation
of geometric facts

may indicate their method of doing future geometric prob-

Table 3 shows the number from 15 studies that found the following specific abilities necessary for probable success in geometry.

Table 3. Number of Studies Considering Each Ability Necessary for Success in Geometry

Specific Ability	Number from 15 Studies		
General intelligence	9		
Algebra	8		
Image and understand spatial			
relationships	6		
Perform geometric tasks	4		
Arithmetic	3		
English	2		
Understanding of ratio and			
proportion	1		

more detailed study of the Lee Test of Geometric Aptitude, the Iowa Plane Geometry Aptitude Test, and the Orleans Geometry Prognosis Test, the Lee Test of Geometric Aptitude-Form A has been used in this study as a prognostic instrument. The Lee Test covers the specific abilities previously listed. Its reliability is .911 \frac{1}{2} .011. In checking its validity the authors found the coefficient of correlation between the aptitude test and achievement test to be .72 \frac{1}{2} .028 in 135 cases in one school; in five schools the correlation ranged from .477 to .637. In addition the length of the school period of the pupils in this study provided sufficient time for the Lee Test.

The Revised Minnesota Paper Form Board Test-Series

AA 2 has also been used and the results correlated with
geometric schievement. The Minnesota Test is a test of
mechanical ability but it is considered in this paper because it uses geometric figures, geometric movement,
symmetry, and requires the ability to visualize and study
a geometric figure.

In this study the ninth-grade algebra mark, I.Q., score on Lee Test, and score on Minnesota Test have been correlated with geometry achievement in the first semester 1/See appendix, p. 42.
2/Ibid,p. 43.

. as me sured by teachers' marks and by an achievement test.



CHAPTER II

CORRELATION BETWEEN PREDICTIVE SCORES AND ACHIEVEMENT SCORES

Lee Test of Geometric Aptitude

On the third day of school in September, 1944, the Lee Test of Geometric Aptitude-Form A was administered to ninety pupils in three different classes of tenth-grade geometry. The first day was devoted to registration and the second day to a review of algebra with no reference to geometric figures or formulas. Of the ninety pupils only six had previously studied geometry and failed. The scores on the Lee Test of these six pupils who were repeating geometry ranged from 0 to 57 out of a possible score of 80. This range is wide enough and the number of scores is small enough not to influence the total scores in any direction. Therefore the six repeaters are included in the total ninety without further consideration. The remaining 84 pupils had no training in either intuitive or demonstrative geometry.

The scores on the Lee Test, Table 4, are lower than the norms for the test published in the test manual. This is partly due to the honor class system. Approximately

 placed in two honor divisions in tenth-grade geometry.

These two groups cover nore subject matter and do more originals than the regular geometry classes. The three classes used in this study are resular geometry classes.

There is no need of an instrument to predict success or

Table 4. Distribution of Lee-Test Scores for 90 Pupils

Scores on Lee Test	Number of Pupils
60-69 50-59 40-49 30-39 20-29 10-19	5 4 11 20 26 16 3
rotal	90

pupils who do have difficulty are given individual help until the difficulty is cleared up. If it is discovered that they cannot keep up with the honor divisions, they are transferred to the regular classes where the slower method presents no difficulties for them.

Of the ninety pupils who took the Lee Test, two pupils transferred to a different school before the semester ended and their geometry marks were not available.

Of the remaining 88 pupils, 13 were transferred to a different geometry teacher in the same school and their marks are included.

Teachers' geometry marks and Lee-Test scores. -- For these 88 pupils the scores on the Lee Test have been correlated with the teachers' first-semester geometry marks.

The Lee Test scores in no way affected the teachers' marks as the tests were set aside in September and not scored until after the first-semester marks were recorded. The coefficient of correlation between the teachers' marks and the Lee-Test scores, listed in Table 5, is .63 - .04.

This value of r, .63 - .04, denotes that there is a significant fairly substantial relationship between the Lee-Test scores obtained in September and the teachers' geometry marks of the following January. Therefore the Lee Test can be used as an instrument for predicting success in geometry. A pupil's probable mark in geometry can be estimated from his Lee-Test score by means of the regression equation between the Lee-Test scores and geometry marks of previous classes.

It must be remembered, however, that this is an estimated, probable mark determined by using means of scores obtained from a sample group. An r of .63 has 22% 1/See appendix, p. 46.

20.

efficiency in predicting. Such a mark should be only a starting point in guiding a pupil to study or not to study geometry. The whole individual pupil must be considered.

Of the 18 pupils who obtained a score below 17 in the Lee Test, 14 failed geometry and 4 passed. One of the

Table 5. Distribution of Teachers' Geometry
Marks and Lee-Test Scores for 88
Pupils

Scores on Lee Test	Teachers' First-Semester Geometry Marks												
	10	20 29	30 39	40		60	70 79	80 89	90 99	Total			
1	2	3	4	5	6	7	8	9	10	11			
60-69 50-59 40-49 30-39 20-29 10-19	1	2	313	2 2 2 1	1 46 5 2	1 460061	2562	2 2 1 3 1		5 11 19 25 16 8			
Total	1	3	7	7	18	28	14	9	1	38			

four had transferred from Georgia and had taken the Lee
Test on his third day in a school to which he had not yet
become adjusted. A second boy of the four proved to be a
consistently slow worker defeated by the timing in the Lee

1/Henry E. Garrett, Statistics in Psychology and Education. Longmans, Green and Co. New York, 1941, p. 346.

Test. A third boy, whose Lee-Test score was zero, was a repeater definitely provoked to be with the same teacher who had "failed" him the preceding year. He was transferred to another teacher. The fourth pupil was also transferred to another teacher before the reason for her taking geometry in the eleventh grade was discovered. It would have been most unwise to advise at least the first three of these pupils solely on the basis of the Lee-Test score.

As Test 2 in the Lee Aptitude Test is distinctly different from the other three tests - containing no geometry, the combined scores on Tests 1, 3, and 4 have been correlated with the teachers' semester marks; the coefficient of correlation is .56 \(\frac{1}{2}\). O5.\(\frac{1}{2}\) Between Test 2 scores and teachers' marks the coefficient of correlation is .48 \(\frac{1}{2}\). O5.\(\frac{1}{2}\) The entire Lee-Test score including arithmetic, algebra, and geometry is a better predictive instrument than its individual tests. This is perhaps because all three subjects are needed for tenth grade geometry.

Achievement-test scores and Lee-Test scores. -- Only 65 of these 38 pupils took the geometry achievement test given at the end of the first semester after Book I had been completed. The distribution of scores is shown in Table 6. The 13 pupils who had been transferred to a 1/ See appendix, p. 47.

2/ Ibid, p. 48.

different geometry teacher did not take the same test; ten other pupils were absent and took a make-up test later. The Lee-Test scores of these 65 pupils have been correlated with the scores on the achievement test. The coefficient of correlation is $.69 \pm .04$. An r of .69 has 28 per cent efficiency in prediction.

Table 6. Distribution of Achievement-Test Scores and Lee-Test Scores for 65 pupils

Scores on		Achievement-Test Scores												
Lee Test	0 9	10	20	30 39	49	50 59	60	70 79	80 89	90	Total			
1	2	3	4	5	6	7	8	9	10	11	12			
60-69 50-59 40-49 30-39 20-29 10-19	1	1 1	352	233	3521	23431	1	1 1 4 1	2 3 1 1	2	5 36 14 18 15			
Total	1	3	10	8	11	13	2	7	7	3	65			

The value of r, then, is slightly higher for the achievement test scores (.69 ± .04) than for the teachers' marks (.63 ± .04) in relation to the Lee-Test scores. This is very often the case. It has previously 2/ been noted 1/See appendix, p. 49.

2/See p. 9.

. that the correlation between test marks and teachers' marks is not perfect. Both the test scores are objective whereas the teachers' marks tend, perhaps unfortunately, to be subjective.

The difference between the two values of r is not unduly great. This is due to the fact that pupils usually do about the same level of work on the achievement test as they have done during the semester. Also the achievement-test score is included in the semester mark. Therefore the Lee Test can be used as an instrument of prediction of success in geometry whether measured by teachers' marks or by achievement-test scores.

Revised Minnesota Paper Form Board Test

Teacher's geometry marks and Minnesota-Test scores.—

At the beginning of the second week of school, after

classes had been readjusted for size, the Revised Minnesota

Paper Form Board Test-Series AA was administered to 80

pupils in the same three geometry classes. Of the six

pupils who were repeating meametry and who took the Lee

Test of Geometric Aptitude, only three took the Minnesota

Paper Form Board Test. Their scores were 30, 38, and 52

in a score range of 20 to 62 out of a possible score of 64.

The three scores are included in the total 80. For these

80 pupils the scores on the Minnesota Test have been

(E

correlated with the teacher's first-semester marks in geometry. The distribution of these scores is shown in Table 7. The coefficient of correlation between the teacher's marks and the Minnesota-Test scores is .32 - .07.

Table 7. Distribution of Teacher's Geometry Marka and Minnesota-Test Scores for 80 Pupils

Scores on Kinnesota	ę	Teacher's First-Semester Geometry Warks											
Test	20	30 39	40	50 59	60 69	70 79	80 89	90 99	Total				
1	2	3	4	3	6	7	8	9	10				
60-64 55-59 50-54 45-49 40-44 35-39 30-34 25-29 20-24	1	2 1 2	1 2 2 1	1123422	34763	114131	1 2 3 3 1 1	2	1 4 7 14 16 21 7 5				
Total	2	5	6	15	26	11	12	3	80				

Achievement-test scores and Minnesota-Test scores:-Of the 30 pupils who took the Minnesota Test only 76 took
the achievement test at the end of the first semester.

1/3ee appendix, p. 50.

Four were absent and took a make-up test later. The Minnesota-Test scores have been correlated with these achievement-test scores. The distribution of these scores is shown in Table 8. The coefficient of correlation between the achievement-test scores and the Minnesota-Test scores is $.36 \stackrel{+}{-} .07. \stackrel{1}{-}$

Table 8. Distribution of Achievement-Test Scores and Minnesota-Test Scores for 76 Pupils

Scores on Minnesota Test	Achievement-Test Scores												
	9	10	20	30	40	50 59	60 69	70 79	80 89	90	Total		
1	2	3	25	5	6	7	8	9	10	11	12		
60-64 55-59 50-54 45-49 40-44 35-39 30-34 25-29	1	1	114131	133	2323	21344	1 2 1	1 4 2	1 113211	1 2 1	13613612754		
Total	2	2	11	7	11	16	5	7	10	5	76		

These values of <u>r</u> show a very slight correlation between the teacher's marks and the Minnesota-Test scores and between the achievement-test scores and the Minnesota
1/See appendix, p. 51.

/ Wales III and III and

Test scores. It is usually agreed that the correlation between a mechanical ability test and a mental ability test does not tend to be as high as the correlation between two tests of mental ability. The test manual, for instance, states that the test is predictive of the ability to learn descriptive geometry and quotes a correlation of .32, which by chance is the same value of r obtained in this paper between the Minnesota-Test scores and the teacher's marks in demonstrative geometry. The test manual does not consider demonstrative geometry.

In this school system there is a good technical high school. The majority of the boys with a high degree of mechanical aptitude who would study geometry with mechanical interest attend the technical high school. None of these tenth-grade boys are included in this paper. The great majority of the pupils in the three classes considered here study geometry because it is required in the college course. This fact may have some bearing on the value of r.

On the basis of these 30 scores alone the Minnesota Test cannot be considered an adequate instrument for predicting success or failure in tenth-grade geometry. A more significant value of <u>r</u> might result if the Minnesota-Test scores were obtainable for all the tenth-grade pupils 1/Garrett, op. cit., p. 343.

 about to begin the study of geometry, regular divisions, honor divisions, and technical school divisions, to be correlated with the teachers' first-semester marks.

Intelligence Test

In the high school in which this study was made the Pintner General Ability Test-Form A is administered by the Testing Department to all pupils during their first year in the school. The I.Q.s are not disclosed to the teachers so that they cannot influence the teachers' marks. It is the duty of the deans and masters to study the grammar-school records, the I.Q.s, and the high-school achievement of all pupils and to advise the pupils under their jurisdiction. The I.Q.s used in this paper were given to the geometry teacher after the entire-year geometry marks had been completed.

of the six pupils whose I.Q.s are above 140, two were not in the honor division because it is restricted to tenth-grade pupils who attended the same school the previous year; two others were boys who professed no interest in mathematics and who got only a passing mark in ninth-grade algebra; the two remaining pupils were boys who had so many stronger interests, such as music and athletics, that it seemed wiser not to burden them with the extra work in the honor division.

Teachers' geometry marks and intelligence quotients.—
The I.Q.s of these 96 pupils have been correlated with
the teachers' first-semester geometry marks, distributed
as shown in Table 9, with the exception of seven pupils
who were repeating geometry. For these pupils the failing

Table 9. Distribution of Teachers' Geometry
Marks and Intelligence Quotients
for 98 Pupils

I.Q.	Teachers First-Semester Geometry Marks											
	20	30 39	40	50 59	60 69	70 79	80 89	90 99	Total			
1	2	3	4	3	6	7	8	9	10			
150-159 140-149 130-139 120-129 110-119 100-109 90- 99 80- 69 70- 79	1	3121	4 3 31	11348311	2 2 5 9 6 8	1 5 3 1 1	3321	1	3 7 20 26 17 17			
Total	2	7	11	22	32	12	10	2	98			

marks of the preceding year were used as it is precisely the original success or failure in geometry that is of interest. The I.Q. is not affected by the repetition of geometry. On the other hand when computing the correlation between the Lee-Test scores and the first-semester

and the first-semester geometry marks, the passing marks of the repeated semester were used since all the factors, Lee-Test scores, Minnesota-Test scores, and repeated-semester marks were affected by the knowledge of geometry assimilated in the preceding year. The coefficient of correlation between the teachers' marks and the I.Q.s is .41 \frac{1}{2} .05.2 There is then a positive relationship but it is not of very high degree. The following interpretation is given by Garrett: ..., the correlation must be .70 or more between general intelligence measures and school grades ... to be considered high, since r's in this field usually run from .40 to .60. An r of .40 has only 8 per cent efficiency in predicting.

Achievement-test scores and intelligence quotients.—
Of the 98 pupils in Table 9 only 75 took the achievement
test at the end of the first semester receiving scores as
in Table 10. The coefficient of correlation between the
achievement-test scores and the I.Q.s is .46 - .06.5/This
1/See p. 15.

^{2/}See p. 21.

^{3/}See appendix, p. 52.

^{4/}Garrett, loc. cit.

^{5/}See appendix, p. 53.

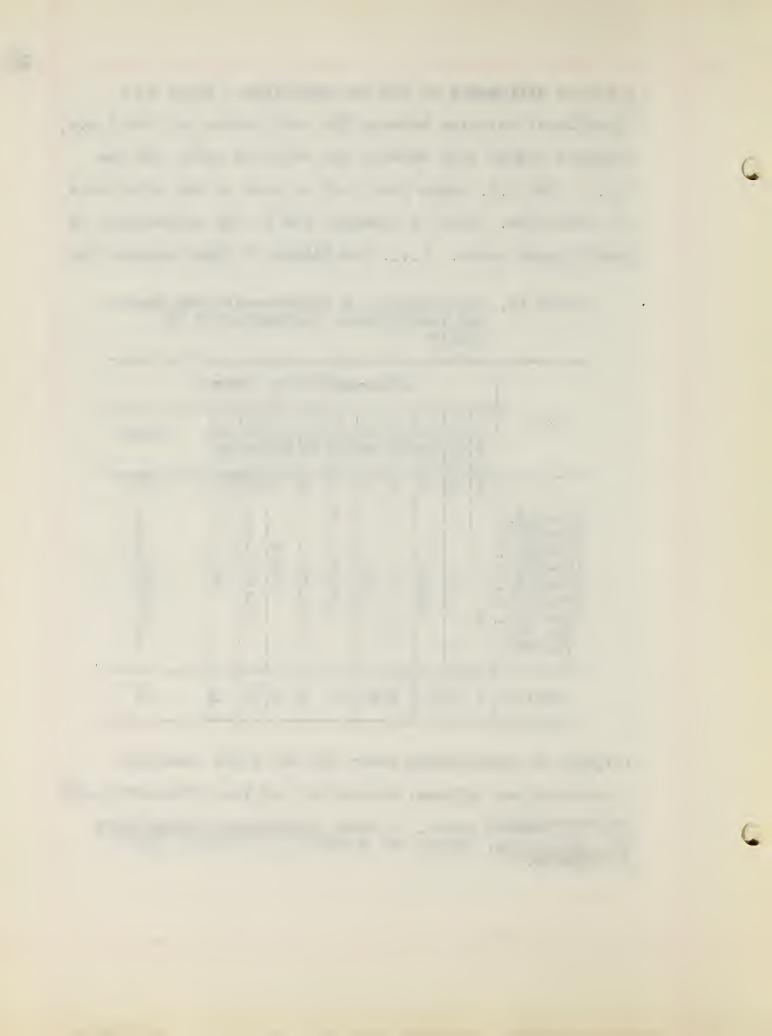
r has an efficiency of lift in prediction. There is a significant relation between the test scores and the I.Q.s, slightly higher than between the semester marks and the I.Q.s. The I.Q. alone could not be used as the only basis of prediction. This is probably due to the composition of intelligence tests. "... the nature of their content may

Table 10. Distribution of Achievement-Test Scores and Intelligence Quotients for 75 Pupils

of 630 s		Achievement-Test Scores												
I.Q.	0 9	10	20	30 39	49	50 59	60 69	70 79	80 89	90 99		Total		
1	2	3	4	5	6	7	8	9	10	11	····	12		
150-159 140-149 130-139 120-129 110-119 100-109 90-99 80-89 70-79	1	1	2252	3 4 1	2223	2 1 7 1 2	1 1 1 1	4 2 2	1113211	1 2 2		3 6 14 22 11 14 1		
Total	2	3	11	8	10	14	4	8	10	5		75		

largely be comprehended under the two major language systems of our culture: the verbal and the mathematical.

^{1/}H. H. Remmere and N. L. Gage, Educational Measurement and Evaluation. Harper and Brothers. New York, 1943, p. 298-299.



The I.Q. combines the scores and hides any comparison between the two. Of three pupils with the same I.Q. one may excel in verbal, one in mathematical, and one may be balanced in both fields. A test of mathematical ability, such as the Lee Test of Geometric Aptitude, gives a score based on the special mental ability rather than general mental ability.

It would seem from Table 9 that a line of demarcation may be determined - pupils below a certain I.Q. will very probably fail geometry. According to this table the five pupils with I.Q. below 90 failed. Of course the work of five pupils does not constitute a law. But if records are kept year after year it seems probable that there will accumulate a list of pupils with I.Q.s below a critical one who invariably failed. This of course is not confined to geometry. It would be of interest to inquire what the five pupils with I.Q. below 90 achieved in other subjects and why their parents wish them to attend college.

Algebra Marks

The teachers' ninth grade algebra marks (the yearly average) were produced for 105 pupils after the tenth-grade geometry marks were recorded. The other eight pupils in this paper were transferred from schools with different marking systems; their marks had not yet been transposed. For four pupils who had failed ninth-grade

algebra and passed it in their tenth grade an average of the failing ninth-grade mark and the passing tenth-grade mark was used. It is of interest to note that very few pupils who repeat ninth-grade algebra take plane geometry in the eleventh grade. Of the four in this study three failed the first semester of geometry. The one pupil who passed was a post-graduate pupil, more mature than the customary geometry pupils, who came back to high school to try to get enough credits to enter college. Of the 105 recorded ninth-grade algebra marks, 78 were given by 6 different teachers in the school in which this study was made. The remaining 27 pupils came from at least 15 different schools. Only 12 pupils had the same teacher in ninth-grade algebra and tenth-grade geometry.

As noted before, the honor division is restricted to tenth-grade pupils who attended the same school the previous year. Of the 12 pupils with algebra marks above 80, as listed in Table 11, five were not in the honor division because they were eleventh-grade pupils, four had taken algebra in a different school, one had started in the honor division but transferred to a regular division in November, the last two were girls who were not too interested in mathematics and preferred the regular division.

^{1/}See p. 25.

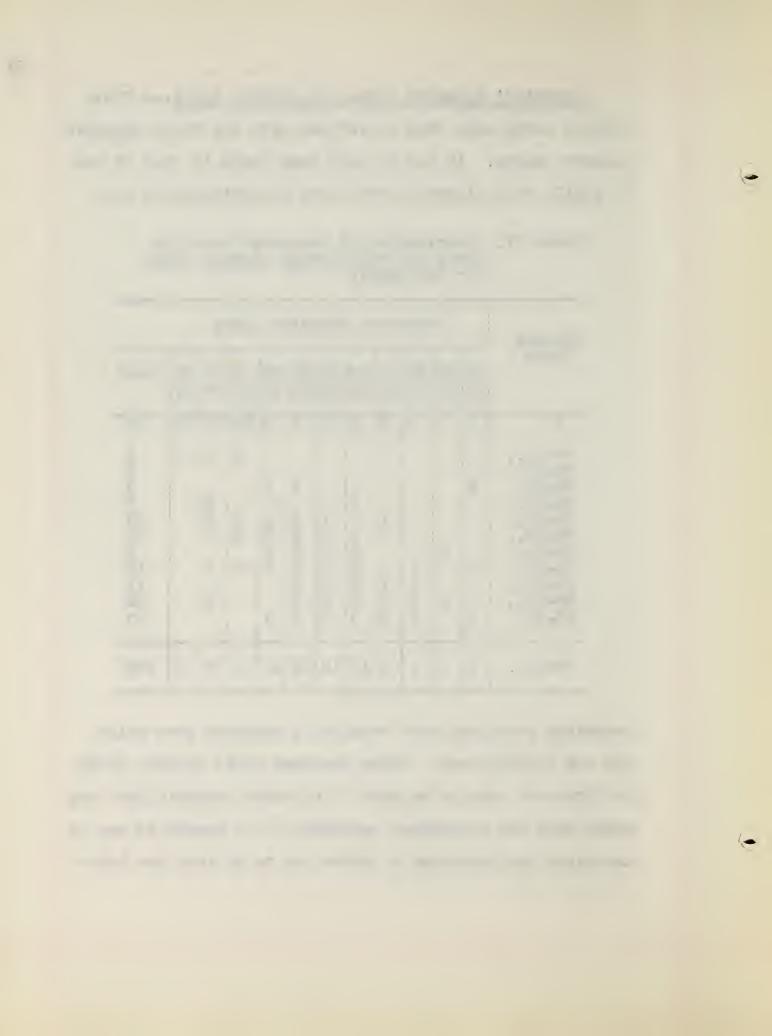
.

Teachers' geometry marks and algebra marks. These algebra marks have been correlated with the first-semester geometry marks. It can be seen from Table 11 that of the 12 pupils with algebra marks above 80 mentioned in the

Table 11. Distribution of Teachers' Geometry
Marks and Ninth-Grade Algebra Marks
for 105 pupils

Algebra Marks		Teachers' Geometry Marks													
	21 27	28 34	35 41	42	49		63	70 76	77 83	84 90	91 97	Total			
1	2	3	T	3	6	7	8	9	10	11	12	13			
90-92 87-89 84-86 81-83 78-80 75-77 72-74 69-71 66-68 63-65 60-62	1	1	1 1 1 2	1 1 3 3	2 132143	1 11627	3524246	1 5211	1 2 1	1 2 1 1	2	6 0 3 13 10 8 12 11 16 23			
Total	3	2	5	9	16	18	27	11	5	7	2	105			

preceding paragraph four received a geometry mark below 60- the passing mark. Three received their algebra marks in different schools so that it is quite possible that the marks were not transposed correctly. The fourth is one of the girls who expressed a desire not to go into the honor



division - she knew her limitations.

marks and geometry marks is .43 + .05. This r has an efficiency of 10 per cent for prediction. There is, then, a definite relationship between the algebra marks and geometry marks. But the coefficient of correlation is not high enough to warrant the use of the algebra mark as the only instrument of prediction. Comparison of an analysis of the abilities required for success in algebra and a similar analysis for geometry may reveal enough difference in the requisite abilities to account for part of the low correlation.

Achievement-test scores and algebra marks.— Of these 105 pupils only 82 took the achievement test given at the end of the first semester. The scores are shown in Table 12. The coefficient of correlation between the algebra marks and the achievement-test scores is .51 ± .05.2/
This again shows that, although the algebra marks alone cannot be used authoritatively to predict success in geometry, still there is a definite relationship between the algebra marks and the geometry achievement-test scores so that the algebra marks can be used as one instrument for prediction.

^{1/}See appendix, p. 54.

^{2/}Ibid, p. 55.

Multiple Coefficients of Correlation

Now the four instruments for prediction have been correlated with the teachers' first-semester geometry marks listed in Table 13 and none yielded a coefficient of correlation high enough to warrant its use as a single

Table 12. Distribution of Achievement-Test Scores and Ninth-Grade Algebra Marks for 82 Pupils

Algebra			lch:	Levi	emei	nt-1	lest	t Se	core	8	
Marks	0 9	10	20	30 39	49	50 59	60	70 79	80 89	90 99	Total
1	2	3	4	5	6	7	8	9	10	11	12
90-92 87-89 84-86 81-83				1	1 1	1		1	3	1	5 0 2 3 11
78-80 75-77 72-74		1 1	1	1 2 1	2	3 2 1	31	1	2 2	2	11 9 6 9 8
69-71 66-68 63-65 60-62	1	1	2 1 2 5	1 3	1 2	2 3 5	1	1 1 1	2	1	8 11 18
Total	2	3	11	9	11	17	6	9	10	4	82

efficients of correlation have been computed using the I.Q.s, the ninth-grade algebra marks, the Lee-Test scores, and the teachers' marks in first-semester tenth-grade

geometry to determine if two or more scores will constitute a better instrument for prediction than one score.
The Minnesota-Test scores have not been used as their
correlation with the geometry mark is slight. The
teachers' mark has been used as the measure of achievement rather than the test mark because the teachers' mark
determines the pupils' success or failure in the course.

Geometry marks, intelligence quotients, and Lee Test
scores.— The R between the actual first-semester
geometry marks and the marks estimated by means of the
regression equation made up of I.Q.s and Lee-Test scores

Table 13. Correlation between Single Prediction Instrument and Teachers' Geometry Marks

Instrument	Correlation with Geometry
Lee Test	.63 ± .04 .43 ± .05 .41 ± .05 .32 ± .07

tained for the Lee Test score alone; therefore the extra work involved in using both I.Q.s and Lee-Test scores is 1/3ee appendix for calculation of additional coefficient of correlation, p. 56.

unnecessary.

Geometry marks, algebra marks, and Lee Test scores.—

The R between the actual first-semester geometry marks and the marks estimated by means of the regression equation made up of ninth-grade algebra marks and Lee-Test scores is .68.

marks, and Lee Test scores. — The R between the actual first-semester geometry marks and the marks estimated by means of the regression equation made up of I.Q.s, ninth-grade algebra marks, and Lee-Test scores is also .68. —

It is unnecessary to use three instruments of prediction since two give the same result.

^{1/}See appendix for calculation of additional coefficient of correlation, p. 57.

^{2/}Ibid, p. 58.

2 . .

CHAPTER III CONCLUSION

Highest correlation with algebra marks and Lee-Test
scores.— Since .68 is the highest coefficient of correlation obtained, the ninth-grade algebra marks and the LeeTest scores will be used in initiating the project of predicting success in tenth-grade geometry. Having determined
the regression equations from existing records, the adviser
can estimate the geometry mark and each year advise the
new crop of pupils as soon as they have taken the Lee Test
in September or perhaps at the end of the ninth grade. The
regression equations can be readjusted as more data are
accumulated.

Factors influencing both algebra marks and geometry

marks.-- At present the ninth-grade algebra mark is the

sole criterion in determining which pupils may study

geometry. The coefficient of correlation is only .43. The

algebra mark does not reflect too greatly aptitude for

geometry. The algebra mark does however reflect intelli
gence, interest in mathematics, study habits, health, home

cooperation, influence of extracurricular interests - all

THE RESERVE THE PARTY OF THE PA

of which will in turn affect the geometry mark. The added interest in and aptitude for geometry is brought in by the Lee Test.

The algebra mark also represents the result of good or poor teaching which is equally important to pupils who are studying geometry. But the improvement of the teaching methods is not within the scope of this paper.

Probability of estimated mark dependent on individual pupils .-- As the r of .68 is not perfect correlation, there are two further points to consider. The adviser must bear in mind when planning the pupil's schedule that the estimated mark is a probability. With some pupils the possibility of failure will offer a challenge so that they will work harder and succeed. With other pupils of different temperaments the possibility of failure will discourage them so that they will give up. Throughout the years by compering results the advicer may derive a division into three groups of estimated marks obtained from the regression equations made from the ninth-grade algebra marks and Lee-Test scores. Above a certain score pupils have always passed geometry; below a certain score they have always failed: and between the two scores some pupils have failed and some have passed. The majority of pupils are influenced by the results obtained by other pupils.

The second secon

Further Study

Reading ability. — With an r of .68 the problem is not completed. It is necessary to continue the search for predictive instruments. One that should prove of value in predicting success in geometry is a test of reading ability. If school finances prevent the purchase of such tests, the English mark may be correlated with the geometry mark for possible use in prediction. But as the test of reading ability would be of use in all subjects, such an expenditure would probably be approved.

Instructional value. — Whatever the estimated geometry mark may be, a comparison between it and the marks earned by the pupil month by month affords the teacher an opportunity to study herself and her teaching habits, and the pupil and his study habits in an effort to account for discrepancies. Such a study will result not only in discovering further predictive instruments but in better teaching and better learning.

APPENDIX

First Semester Achievement Test

Part I

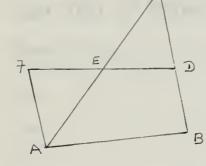
- 1. If angle A is the vertex angle of isosceles triangle ABC and if angle B has 52 degrees, how many degrees in the exterior angle at A?
- 2. Can you draw a briangle with sides 16, 25, and 12 inches respectively? Yes or No.
- 3. Name the longest side in triangle ABC if angle A is greater than angle B and angle C has 60 degrees.
- 4. The sum of the interior angles of an octagon is 540 degrees. True or False.
- 5. In a parallelogram ABCD, angle A has 37 degrees. How many degrees in angle B?
- 6. An angle which is 3 times its supplement has how many degrees?
- 7. In right triangle ABC, angle A is twice angle B. If AB has 15 inches, AC has either or inches. Give both answers.
- 8. How many sides in an equiangular polygon with an exterior angle of 30 degrees?
- 9. Two triangles are not necessarily congruent if 3 of one are equal to the corresponding 3 parts of the other.
- 10. In a triangle the line from a vertex perpendicular to the opposite side extended if necessary is called .
- ll. If the diagonals of a parallelogram are unequal but perpendicular, the figure is _____.
- 12. The size of an angle does not depend on the _____

- 13. When two adjacent angles are equal and formed by two straight lines only, each angle is _____.
- 14. The bisectors of two consecutive angles of a parallelogram form an angle of how many degrees?
- 15. Every polygon has more than 3 sides. True or Felse.
- 16. An altitude of a triangle does not always fall within the triangle. True or False.
- 17. Can you draw a triangle with sides 4, 5, and 9 inches respectively? Yes or No.
- 18. The hands of the clock at 5 o'clock form an angle of how many degrees?
- 19. How many diagonals can be drawn from one vertex in a heptagon?
- 20. Name the shortest side in triangle ABC if angle A is greater than angle B and angle C has 60 degrees.
- 21. The perimeter of the triangle formed by joining the midpoints of the sides of a triangle is 24 inches. Find the perimeter of the triangle.
- 22. The lower base of a trapezoid is 16, the line joining the mid-points of the nonparallel sides is 13. How long is the upper base?
- 23. In parallelogram ABCD if angle A has 37 degrees, how many degrees in angle C?
- 24. If in triangle ABC, BC is greater than AC, then angle A is greater than angle B. True or False.
- 25. Is the converse of "Vertical angles are equal" always true? Yes or No.
- 25. If the diagonals of a parallelogram are equal and perpendicular, the figure is ____.
- 27. If in triangle ABC, AC is greater than BC and the bisectors of angle A and angle B meet at D, is AD greater than, equal to, or less than DB?
- 28. If AM is a median of triangle ABC and angle AMB is acute, is AC greater than, equal to, or less than AM?

Part II

1. Prove: If the bisector of an angle of a triangle is perpendicular to the opposite side, the triangle is isosceles.

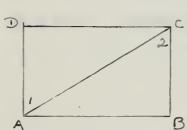
2.



Given: FD and GA bisect each other

Prove: FAIIBC

3.



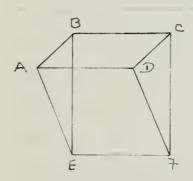
Given:

AD \(\to\) AB BC \(\to\) CD \(\to\)

Prove:

DC II AB

4.



Given:

ABCD is a parallelogram

Prove:

BCFE is a parallelogram

GEOMETRIC APTITUDE TEST

Total Score	
Rating	

LEE TEST OF GEOMETRIC APTITUDE-Form A

Devised by Dorris M. Lee,* and J. Murray Lee, Dean, School of Education, State College of Washington, Pullman, Washington.

Name	Age
School	Grade
City	Date
Boy or Girl	How many semesters have you studied Geometry?

PUPIL'S RECORD

	Possible Score	Pupil's Score	Rating
Test 1.	16		
Test 2.	28		
Test 3.	12		
Test 4.	24		
Total	80		

*Formerly Glendale City Schools, Glendale, California

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Published by California Test Bureau
5916 Hollywood Boulevard., Los Angeles 28, California

Study the explanations carefully.



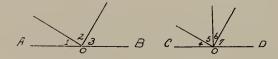
The sum of all the angles of a triangle equals 180°. Example—In the triangle ABC, $\angle 1 + \angle 2 + \angle 3 = 180^\circ$

If two straight lines intersect, then the vertical angles formed are equal.



Example—Since lines AB and CD intersect there are two pairs of vertical angles formed, angles 1 & 2 and 3 & 4. Hence $\angle 1 = \angle 2$ and $\angle 3 = \angle 4$.

The sum of all the successive adjacent angles around a point on one side of a straight line through the point is one straight angle or 180°.

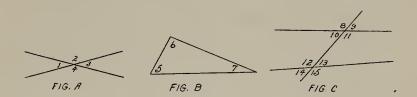


Example
$$- \angle 1 + \angle 2 + \angle 3 = \angle AOB$$

 $\angle AOB = 180^{\circ}.$
or $\angle 4 + \angle 5 + \angle 6 + \angle 7 = 180^{\circ}.$

Test 1—(Continued)

Do the following problems, referring to the Figures A, B, C, and the explanations whenever necessary.



1.	In Fig. A, $\angle 1 = 30^{\circ}$.	∠3 =°
2.	In Fig. B, the sum of $\angle 5$, $\angle 6$, and	∠7 =°
3.	In Fig. A, $\angle 4 = 150^{\circ}$.	∠2 =°
4.	In Fig. A, ∠1	∠2 =°
5.	In Fig. C, what angle or angles are equal to	∠8?°
6.	In Fig. B; $\angle 5 + \angle 6 = 145^{\circ}$,	∠7 =°
7.	In Fig. C, $\angle 14 = 45^{\circ}$,	∠12=°
8.	In Fig. C, $\angle 12 + \angle 13 + \angle 14 + \Box$	∠15=°
9.	In Fig. B, $\angle 5 = 60^{\circ}$. $\angle 6 +$	∠7 =°
10.	In Fig. C,	∠13=°
11.	In Fig. B,	∠6 =°
12.	In Fig. C, $\angle 8 + \angle 9 + \angle 10 = 230^{\circ}$,	∠9 =°

STOP HERE! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO!

No. Right	0	1	2	3	4	5	6	7	8	9	10	11	12
Score	0	1	3	4	5	7	8	9	11	12	13	15	16

Test 2

Apples 4 lbs. for 25c Grapes 7 lbs. for 25c Peaches 3 lbs. for 20c

Bananas 2 lbs. for 25c Lemons 3 for 5c Prunes 2 lbs. for 25c

Cherries 20c a lb. Raisins 10c a box Melons 15c each

Grapefruit 6 for 25c Oranges 3 for 10c Tomatoes 5c a lb.

Prices of the various fruits and vegetables are listed above. Supply the missing numbers in the following problems as shown in samples A, B, and C.

SAMPLES:

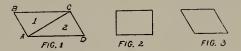
- A. 4 lbs. apples costs......JUST.....as much as 6 grapefruit.
- B. A melon cost.......3 TIMES......as much as a lb. of tomatoes.

Test 2—(Continued)

	Do these the same way. Reduce fraction	onal answers to lowest terms.
1.	1. 7 lbs. of grapes cost	as much as 4 lbs. of apples.
2.	2. 3 lemons cost	as much as a box of raisins.
3.	3. 12 oranges cost	as much as 1 lb. of cherries.
4.	4. 8 lbs. of bananas cost	as much as 3 lbs. of peaches.
5.	5. A melon costs	as much as 2 lbs. of tomatoes.
6.	6. 6 lbs. of prunes cost	as much as 18 grapefruit.
7.	7. 1 lb. of peaches costs	as much as 1 lb. of cherries.
8.	8. 6 oranges cost	as much as 8 lbs. of apples.
9.	9. 4 boxes of raisins cost	as much as 9 lemons.
10.	10. A dozen grapefruit costs	as much as 3 lbs of tomatoes.
11.	11. 4 lbs. of bananas cost	as much as 1 melon.
12.	12. 2 lbs. of bananas and	
	a box of raisins cost	as much as 3 oranges.
13.	13. 6 lbs. of peaches and	
	3 lemons cost	as much as 7 lbs. of grapes.
14.	14. 2 lbs. of cherries and	
	2 lbs. of prunes cost	as much as 3 lbs. of peaches.

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No. Right													12		
Score	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28



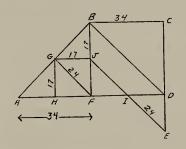
In geometry, figures are called by the letters which are at each of their corners. Lines are named by the letters as each end. For example, the horizontal lines in Figure 1 are BC and AD. This figure is a parallelogram. That means that the opposite sides are parallel, that is, run in the same direction. Line AB is parallel to line CD and line BC is parallel to line AD. The figure is named ABCD. Figures 2 and 3 are also parallelograms. In a parallelogram the opposite sides are equal as well as parallel. That is, if AB is 10 ft., CD is also 10 ft. Or if BC is 25 ft., AD is also 25 ft.

Figure 1 is divided into 2 triangles by line AC. Triangle 1 is called \triangle ABC, and triangle 2 is called \triangle ACD

Perimeter means the distance around a figure, as the perimeter of \Box ABCD = AB + BC + CD + AD = 10 + 25 + 10 + 25 = 70 ft.

Test 3—(Continued)

Look at the next figure. You are given the length of some of the lines, find the length of the lines and perimeters asked for and put the answers in the answer column. The numbers on the lines indicate the length of the line between the letters.



		Answer Column
1.	How long is HF?	(1)
2.	How long is AH?	(2)
3.	How long is BF?	(3)
4.	How long is JI?	(4)
5.	What is the perimeter of GJIF?	(5)
6.	What is the perimeter of \triangle GJF?	(6)
7.	How long is BD?	(7)
8.	What is the perimeter of [FBCD?	(8)
9.	How long is DE?	(9)
10.	How long is ID?	(10)
11.	What is the perimeter of △ IDE?	(11)
12	What is the perimeter of BIED?	(12)

STOP HERE! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO!

No. Right	0	1	2	3	4	5	6	7	8	9	10	11	12
Score	0	1	2	3	4	5	6	7	8	9	10	11	12

Perimeter means the distance around an object. Area is found by multiplying length by width. Volume is found by multiplying length by width by height. Do the following problems:

cori.

Tha

dire

AD.

para

pare AD

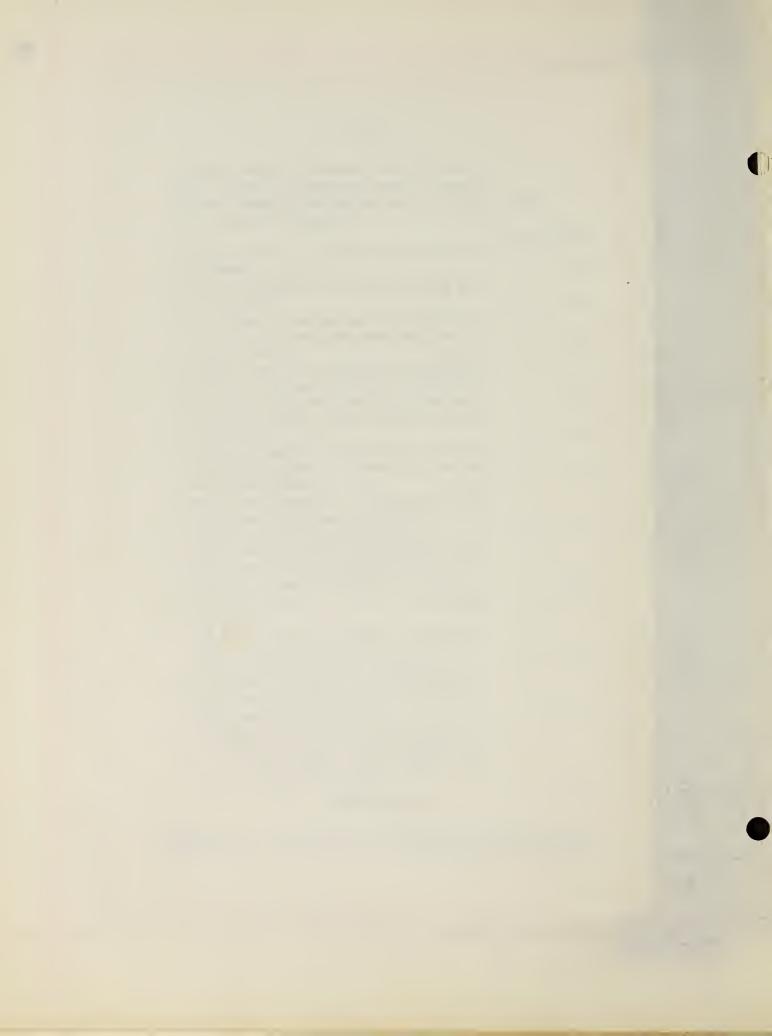
 Δ 1

70 f1

	Do the following problems:	
	XX71	Answer Column
1.	What is the area of a board L feet long and W feet wide?	(1)
2.	What is the perimeter of a board L feet long and	(1)
۵.	W feet wide?	(2)
. 3.	If a rectangle A feet long and B feet wide was	••••
•	divided into two equal parts, what would be the	
	area of one part?	(3)
4.	What is the area of a rectangle that is formed by	
	placing two equal squares of paper side by side?	
	The side of the square of paper is S inches long.	(4)
5.	What is the perimeter of the rectangle described	
	in problem 4?	(5)
6.	If from a rectangle L feet long and W feet wide	
	a square B feet wide is cut, what is the area of	(6)
~	the remaining figure?	(6)
7.	From a piece of cloth C feet long and D feet	
	wide, a piece A feet long and D feet wide is cut, what is the area of the remaining piece?	(7)
8.	From a square of tin, the side of which is X, two	(/)
0.	smaller squares, each Y feet long, have been cut.	
	What is the present area of the piece of tin?	(8)
9.	What is the volume of a cube if E is the length	(0)
	of one edge?	(9)
10.	Each face of a cube is a square. If the edge of	, ,
	a cube is E, the area of one face is E2. Write a	
	formula for the total surface of the cube.	(10)
11.	If two cubes, the edge of each E feet long, are	
	placed side by side, what would be the volume	
10	of the resulting rectangle solid?	(11)
12.	A rectangle 2W feet long and X feet wide is	
	placed beside a rectangle Y feet long and X feet	
	wide so that the width coincide. What is the area of the resultant rectangle?	(12)
	· · · · · · · · · · · · · · · · · · ·	(12)
	STOP HERE!	

STOP HERE!

No. Right	0	1	2	3	4	5	6	7	8	9	10	11	12
Score	0	2	4	6	8	10	12	14	16	18	20	22	24



Score Percentile

SERIES AA

REVISED MINNESOTA PAPER FORM BOARD TEST

Prepared by R. Likert and Wm. H. Quasha New York University *

Fill in the blanks below (name, age, etc.)

BUT DO NOT TURN OVER OR OPEN THE BOOKLET UNTIL THE SIGNAL IS GIVEN PRINT WITH CAPITAL LETTERS

My Name(Last)	(First)	(Middle)
School or Institution		
Toda'y's Date		
(Month)	(Day)	(Year)
Instructor's or Foreman's Name		·
Age Last Birthday	Sex	
	• •	
The Date of My Birth		
(Month)	(Day)	(Year in which you were born)
Grade I Am Now In: Grammar School	1 2 3 4 5 6 7 8 High School ut a circle around the grade you are now in)	1 2 3 4 College 1 2 3 4 5 6 7
Or Department		
DO NOT THINK OF DO	OPEN THE BOOKLET UNTIL	The grant is a divini

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READ THE FOLLOWING DI-RECTIONS VERY CAREFULLY WHILE THE EXAMINER READS THEM ALOUD

Look at the problems on the right side of this page. You will notice that there are eight of them, numbered from 1 to 8. Notice that the problems go DOWN the page.

First look at Problem 1. There are two parts in the upper left-hand corner. Now look at the five figures labelled A, B, C, D, E. You are to decide which figure shows how these parts can fit together. Let us first look at Figure A. You will notice that Figure A does not look like the parts in the upper left-hand would look when fitted together. Neither do Figures B, C, or D. Figure E does look like the parts in the upper left-hand corner would look when fitted together, so E is PRINTED in the square above \(\textstyle{1}\) at the top of the page.

Now look at Problem 2. Decide which figure is the correct answer. As you will notice, Figure A is the correct answer, so A is printed in the square above 2 at the top of the page.

The answer to Problem 3 is B, so B is printed in the square above 3 at the top of the page.

In Problem 4, D is the correct answer, so D is printed in the square above 4 at the top of the page.

Now do Problems 5, 6, 7, and 8.

PRINT the letter of the correct answer in the square above the number of the example at the top of the page.

DO THESE PROBLEMS NOW.

If your answers are not the same as those which the examiner reads to you, RAISE YOUR HAND. DO NOT OPEN THE BOOKLET UNTIL YOU ARE TOLD TO DO SO.

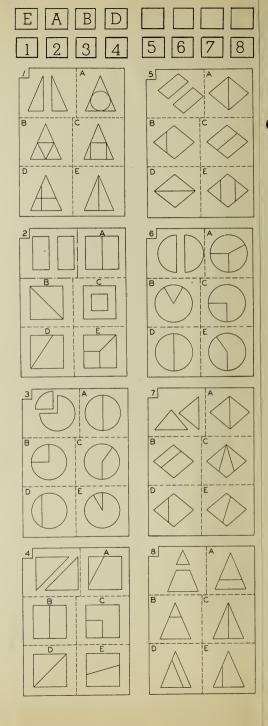
Some of the problems on the inside of this booklet are more difficult than those which you have already done, but the idea is exactly the same. In each problem you are to decide which figure shows the parts correctly fitted together. Sometimes the parts have to be turned around, and sometimes they have to be turned over in order to make them fit. In the square above I write the correct answer to Problem 1; in the square above 2 write the correct answer to Problem 2, and so on with the rest of the test. Start with Problem 1, and go DOWN the page. After you have finished one column, go right on with the next. Be careful not to go so fast that you make mistakes. Do not spend too much time on any one problem.

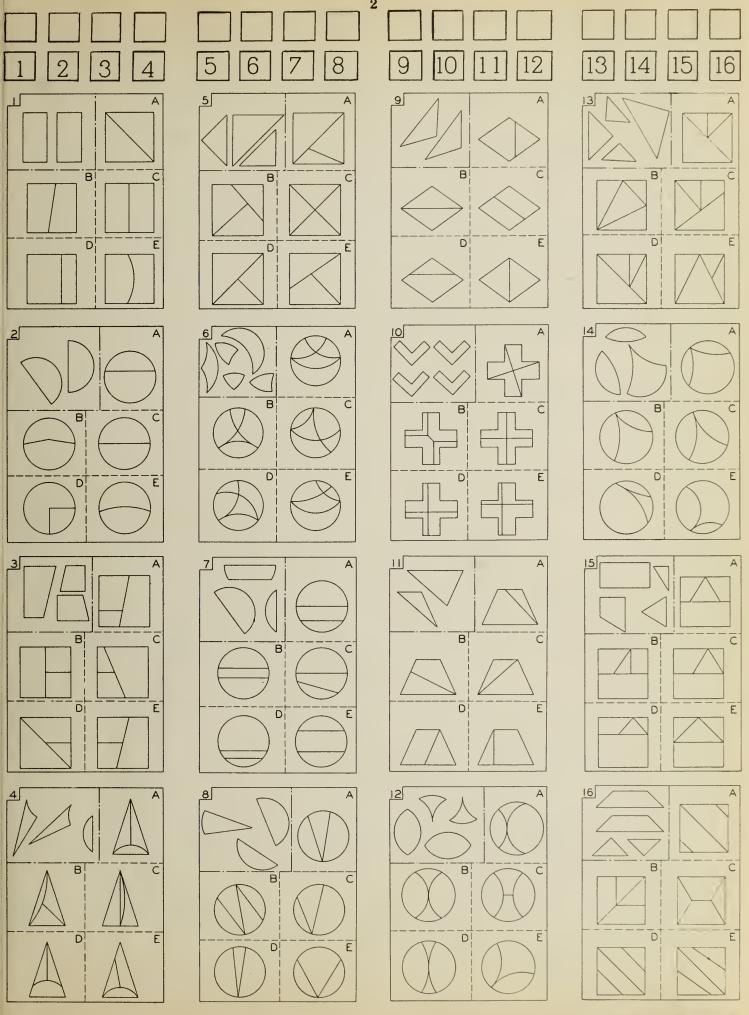
PRINT WITH CAPITAL LETTERS ONLY.

MAKE THEM SO THAT ANYONE CAN READ THEM.

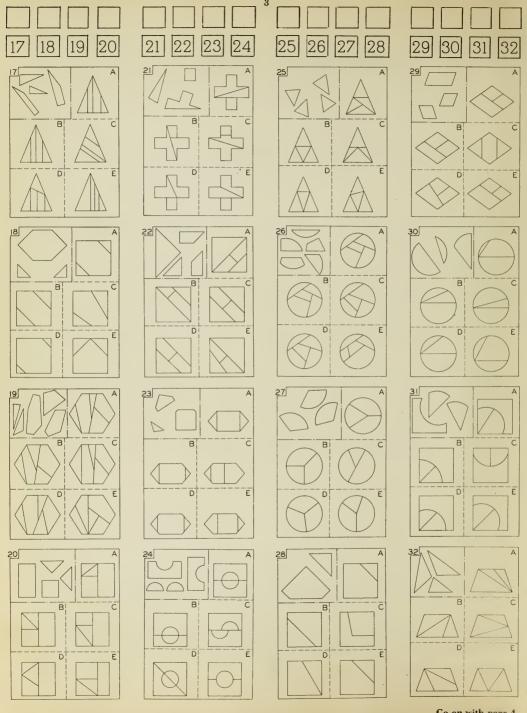
DO NOT OPEN THE BOOKLET BEFORE YOU ARE TOLD TO DO SO.

YOU WILL HAVE EXACTLY 20 MINUTES TO DO THE WHOLE TEST.

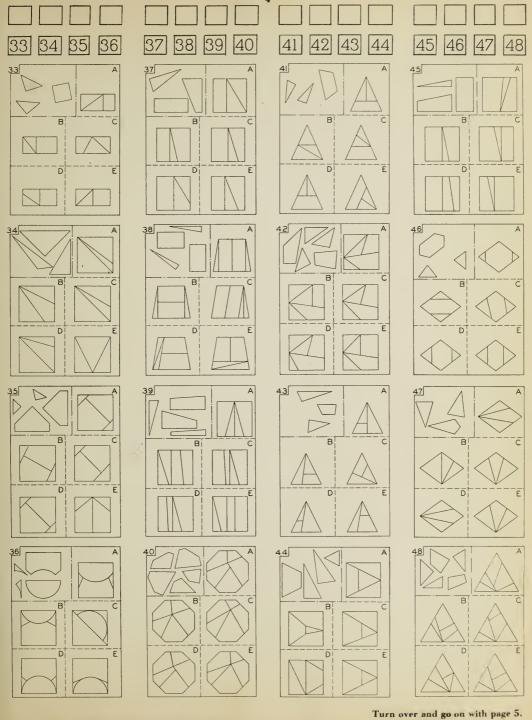


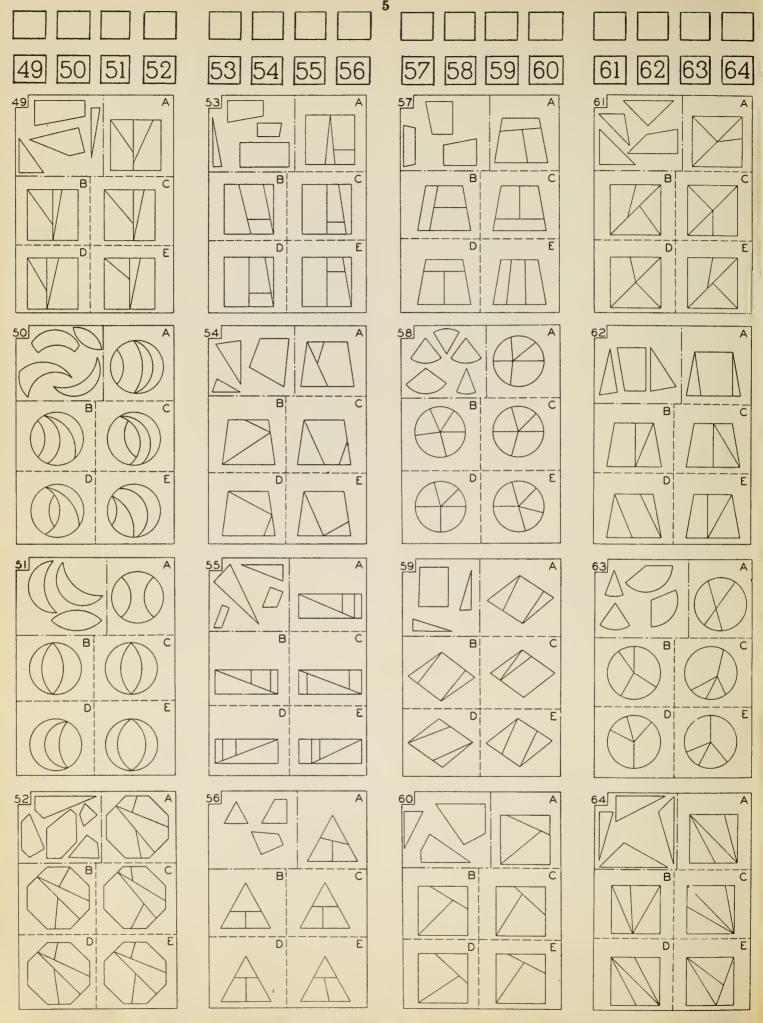


Go on with page 3.



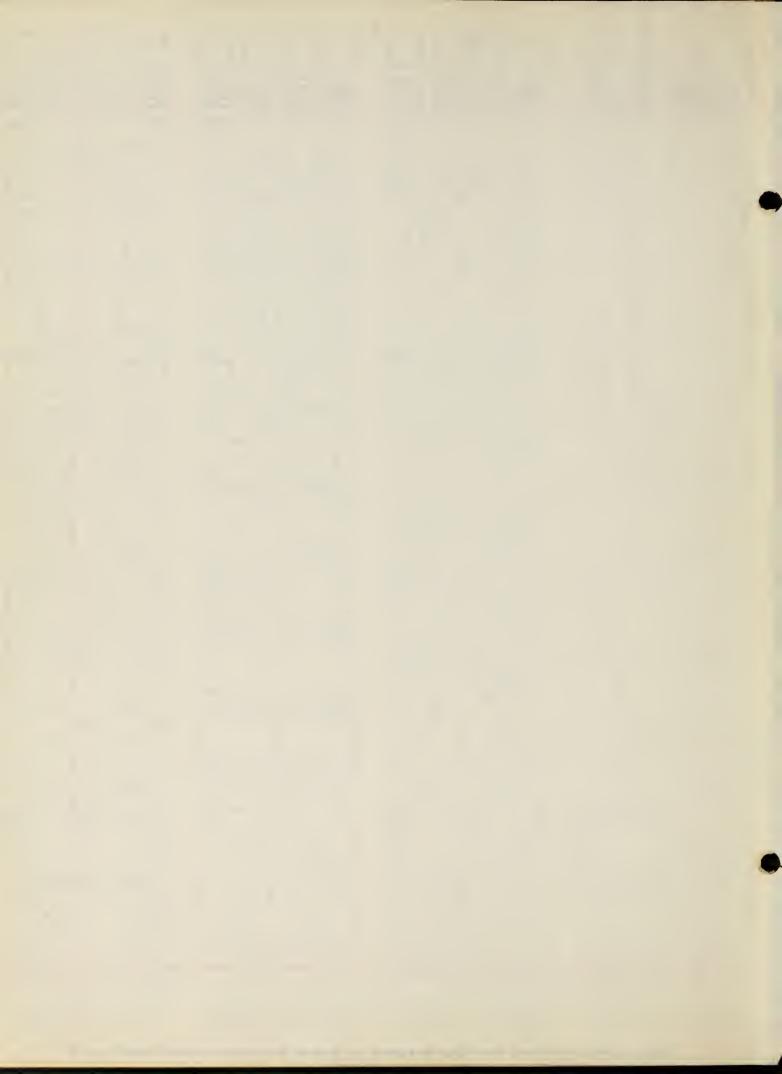
Go on with page 4.



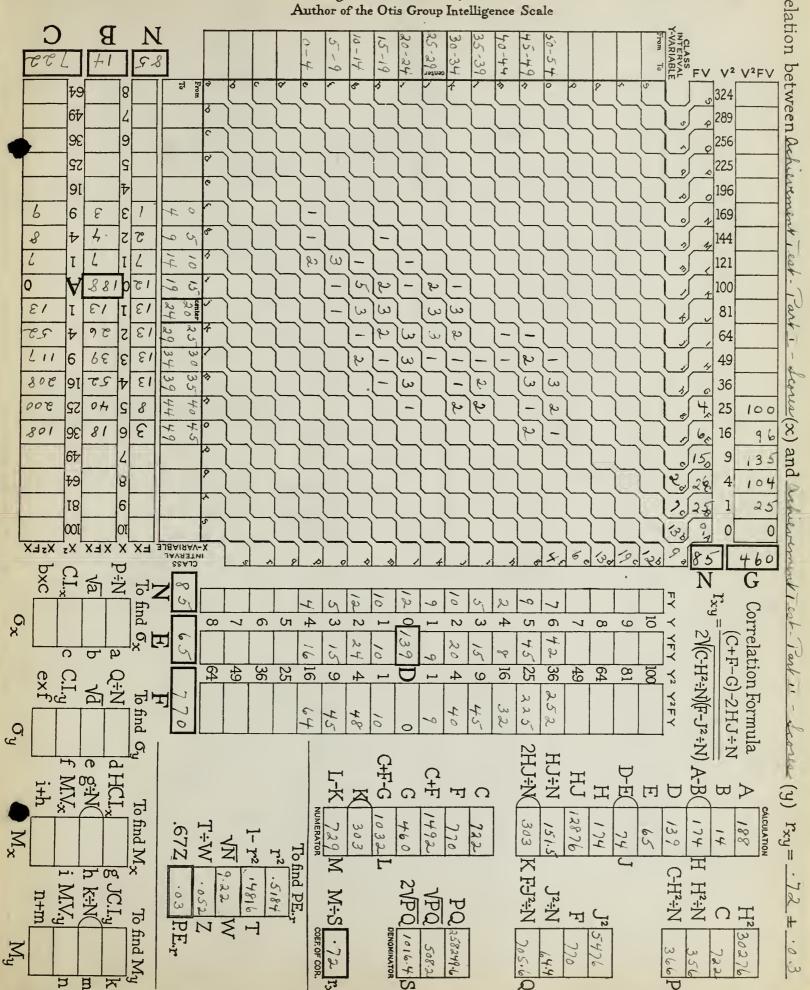


If you finish before you are told to stop, go back and make sure that every answer is right.





OTIS CORRELATION CHART By Arthur S. Otis, Ph.D.



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OTIS CORRELATION CHART Correlation between account By Arthur S. Otis, Ph.D. Author of the Otis Group Intelligence Scale B N CLASS INTERVAL Y-VARIABLE V² 넒 61 ~ c ε w 1-est α 0/ مع S -0 1,00 رى ς and 161 OI X-VARIABLE FX P÷N 당 f_{xy} イエ find Correlation Formula Ox ယ < G S ∞ ယ ∞ X 2\(C-H2+N)(F-J2+N) **YFY Y2 Y2FY** (C+F-G)-2HJ÷N U 泵 ဖ Q÷N To find w Gy 2HJ-N HJ:N d HCI O Nis HU C To find M CALCULATION 664 M 100 KFJ%N To find PE. h K÷N .3916 CH-N M÷S find *U* 8.0. Z Copyright 1922 by World Book Company. Published by World Book Company, Yonkers-on-Hudson, New York, and 2126 Prairie Avenue, Chicago. Copyright in Great Britain.

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Correlation between 1 By Arthur S. Otis, Ph.D. Author of the Otis Group Intelligence Scale B CLASS INTERVAL Y-VARIABLE 79 61 9[ε Gum S 9-5 hi ىع (∞) and \mathcal{L} 16Đ 19 OI XsEX X X EX X-VARIABLE INTERVAL CLASS DXC P÷N G To find σ_x Correlation Formula 16.1 O_X ∞ o) G S ယ ഗ ထ 2\(C-H2+N)(F-J2+N) A-B(YFY Y2 Y2FY (C+F-G)-2HJ÷N مع 4, H find Gy g TOHE HU B To find M لا رو r2.3969 To find PE h k÷N(C-H-N 40. To find S My

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OTIS CORRELATION CHART Correlation between Leacher 47 By Arthur S. Otis, Ph.D. Author of the Otis Group Intelligence Scale B CLASS INTERVAL VARIABLE 0-34 28 1 V2 FV 님 8 75 324 61 289 98 9 256 52 10 5 52 9 20 St 77 8 ىع 9 196 S 89 95 Ju 6 1 S 169 40 38 4 دو 7 S 81 81 81 D w 121 69 88 60 6 S 6 100 41 81 + 2 987 6 81 7 64 6 ε 49 9[ħ 36 25 2 52 (∞) and 2 9 98 16 32 9 61 8 79 6 18 30 OT 0 0 001 CLASS INTERVAL X-VARIABLE FX XEX X5 X 5 P÷N 하 FY 00 find Correlation Formula Gx 10 Y YFY Y2 Y2FY 4 4 S ယ S 9 9 9 Ω 2 2 7 8 ∞ 7 QX 2 (C-H2+N)(F-J2+N) U C+F-G)-2HJ+N 8 N ナア 0 22 36 49 22 81 49 36 25 16 <u>S</u> 16 23 9 4 9 4 To find 72 & 00 Ś Gy 9 HJ÷N 0 大江 82 HU B To find Mx 630 5000 2 304 M Mx 1- r2 60 To find PE. KEN 工 h K-N C-H-N H²·N 임 0 find M DENOMINATOR 0 B 不 Published by World Book Company, Yonkers-on-Hudson, New York, and 2126 Prairie Avenue, Chicago. Copyright 1922 by World Book Company. Copyright in Great Britain. All rights reserved

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OTIS CORRELATION CHART Correlation between a 49 By Arthur S. Otis, Ph.D. Author of the Otis Group Intelligence Scale B CLASS INTERVAL Y-VARIABLE 50 29 FV V2 V2FV 님 79 8 324 61 289 9 36 256 S 52 225 9[Ð 196 9 12 6 ε 8 169 90 20 01 20 20 ىلا 04 7 5 b 144 39 S 8 8 S 121 40 18 w 100 81 81 81 Can S 4 S 8 2 7 60 64 ε 1 29 12 49 000 19115 28 36 (h P 90 -92 5 3 99 25 (∞) and 2 32 16 98 9 60 54 6t 9 64 19 8 6 26 18 OI 0 0 100 χX CLASS INTERVAL X-VARIABLE XsEX XXXX EX PN bxc J. fxy find Correlation Formula S 01 0 G 4 ယ ယ 4 6 ≺ ∞ 2 S ∞ 9 S S 2\(C-H2+N)(F-J2+N) A-B **YFY Y2 Y2FY** U O 22 42 81 49 25 36 49 36 23 Q÷N 16 16 4 4. 9 9 허뇌 2 ىلا 90 ナー find 5 4 Gy 9 HJ:N d HCI 0 MV_x HU B (F) C 님 o find Mx 322.6M 67Z 39.4K FJ%N 39.4 3 90 To find PE h K-N C-H-N 1964. H2:N 40. N-S A PO 엉 A0. 7 find My 160.2 ナバ B Published by World Book Company, Yonkers-on-Hudson, New York, and 2126 Prairie Avenue, Chicago. Copyright 1922 by World Book Company. Copyright in Great Britain. All rights reserved

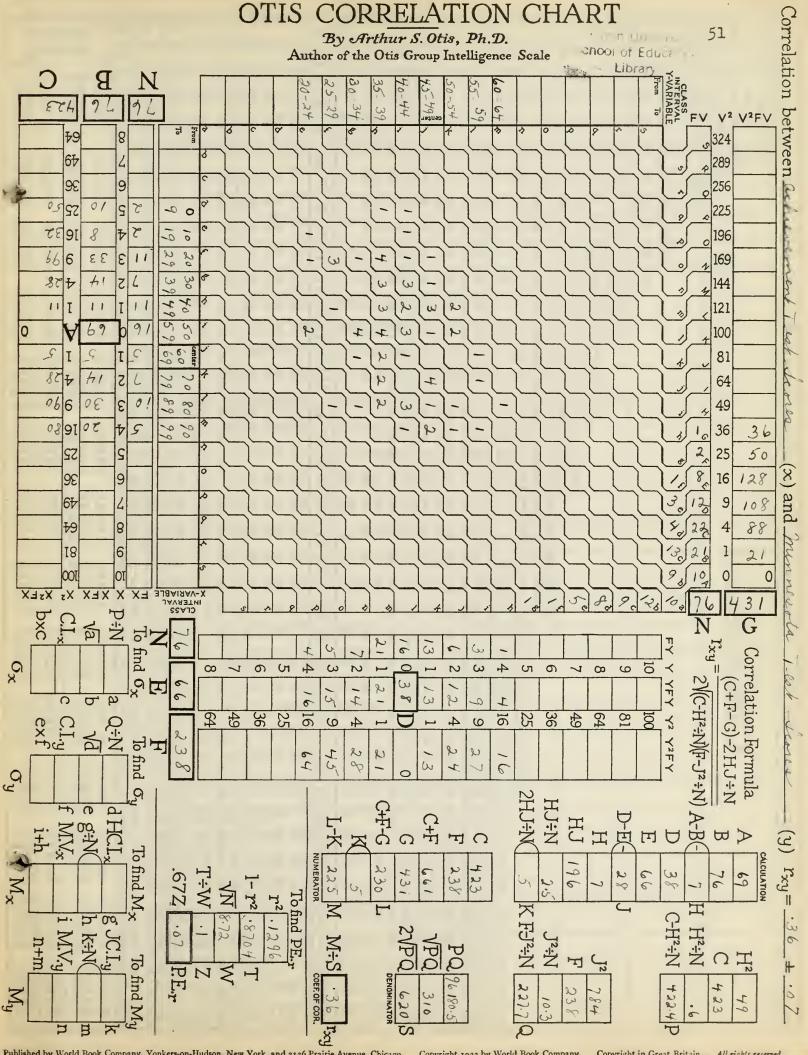
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OTIS Correlation between Lack 50 By Arthur S. Otis, Ph.D. Author of the Otis Group Intelligence Scale B 4-6-6 08 0.9 79 8 324 67 289 9 98 256 52 5 225 200 2 9[8 196 9 SH 3 ىھ p 6 169 949 9 40 HI 7/ 7 2 D 91 51 51 4 121 90 HH F 100 S 6 S 11 7.1 I 1 81 81 00 84 45 2 64 22 3 9 90 6 3 49 2 36 91 25 25 5 25 (∞) and \angle 9 198 16 67 8 79 6 18 1001 OI 0 XXEX CLASS INTERVAL X-VARIABLE FX 南 けっ トイ $f_{x,1}$ find Gx 0 0 G 4 ယ 4 ∞ Ç 2 5 9 00 9 7 7 Q X YFY Y2 Y2FY 2\(C-H2+N)(F-J2+N) A-B U (C+F-G)-2HJ÷N しつ 100 36 25 16 23 36 49 64 Q:N 22 49 81 16 9 4 4 9 F To find 6 カ 90 200 6 6 Gy Q HH 70 ۵ HU C ᄓ ALCULATION find Mx 148 470 20 20 \$ \$ 268 T÷W 152 To find PE. H HAN KEN g JC.I. C-H2+N .8976 · 1024 167 占 find My .07 457. B 不 Published by World Book Company, Yonkers-on-Hudson, New York, and 2126 Prairie Avenue, Chicago. Copyright 1922 by World Book Company.

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OTIS CORRELATION CHART Correlation between I cachera By Arthur S. Otis, Ph.D. 52 Author of the Otis Group Intelligence Scale B CLASS INTERVAL Y-VARIABLE 30-139 40-149 10-1295 8 79 99 FV V2 V2FV 70 19 8 324 ठ 61 289 9 98 256 5 52 225 20 y 35 8 9[196 89 30 2 6 17 3 30 6 169 44 49 22 11 040 7 S ىن + 144 59 75 50 I 25 22 4 Ç 121 00 63 25 60 38 0 يو ع 100 G, 6 13 7 61 01 81 I 000 90 04 5 01 W S 64 9 90 81 3 3 6 49 91 Ď 36 2 25 25 (∞) and 9 64 16 36 08 67 4 9 8 79 28 18 6 OT 0 1000 X CLASS

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OTIS CORRELATION CHART Correlation between de automorphism 53 By Arthur S. Otis, Ph.D. Author of the Otis Group Intelligence Scale B CLASS INTERVAL Y-VARIABLE 12072 500g FV V2 V2FV 겅 324 61 289 9 36 256 52 2 20 84 E 9 19 196 10 66 11 29 N 6 3 20 169 ع در 39 35 91 8 30 0 0 40 w 4 2 100 0 81 fo 8 79 33 91 P 4 64 00 06 90 6 39 ε 0 49 36 9 2 36 08 91 02 25 25 ς 52 28 8 36 9 16 and 90 9 16t 8 76 79 18 6 0 0 X-VARIABLE FX XsEX P÷N Va 하7 FΥ Txy find Gx 6 Correlation Formula Cox 10 Y 7FY Y2 Y2FY ∞ 7 9 G 4 ယ ယ 4 G 9 7 œ 9 2\(C-H2+N)(F-J2+N) A-B (C+F-G)-2HJ÷N U 36 22 2 36 25 16 16 13 49 81 4 ဖ Q÷N 9 4 To find 72 w 5 7 27 00 6 Gy 9 2HJ:N HH e giN (Y H 밁 M hrist = fxx find Mx 657 212 1.76 286 70 44 To find PE. KEN H g JC.Ly h k÷N(C-H-N H²·公 n+m M÷S To find 긔 PF DENOMINATOR 612.4 0 L My

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OTIS CORRELATION CHART Correlation between Lead 54 By Arthur S. Otis, Ph.D. Author of the Otis Group Intelligence Scale B N CLASS INTERVAL Y-VARIABLE 50 62 Ś ಗ FV V2 V2FV 넒 324 8 ₹9 16t 289 9 256 36 5 225 33 X W 8 91 196 35 54 5/ ε 4 2 169 98 7 6 S 144 Ð 2 91 91 الع (J 4 121 2 81 00 يو 100 100 10 Le 6 81 81 S 20 44 22 2 5 O 0 64 05 54 91 9 ε 0 49 0 ع 86 e 19119 Þ 4 36 36 10 6 7 ς 25 55 55 150 N (x) and 9 16 36 9 61 4 8 19 37 6 37 18 OI 0 0 001 X X EX ζX XzEX CLASS INTERVAL X-VARIABLE КH PÜ DXC To find ox fxy Correlation Formula Gx < 10 ယ 4 g ω 7 9 Ot 4 ယ 2 2 G ~ σ 9 2\(C-H2\:\N)(F-J2\:\N) YFY Y2 Y2FY (C+F-G)-2HJ÷N w 42 6 49 36 22 81 2 49 36 25 23 16 16 QHY 9 4 4 ဖ To find 2 117 46 40 84 mark Gy Ģ 2HJ-W HJ÷N J. H.C.I. 0 N-8 (F) H U B To find Mx ALCULATION Exy= 346 490 こと 4 To find PE. r2 .1849 X KEN H HAN h K-N CH-N . 05 M÷S J2:N ᄓ 山 # find 4.641Y 0. 00 $^{1}M_{1}$ Published by World Book Company, Yonkers-on-Hudson, New York, and 2126 Prairie Avenue, Chicago. Copyright 1922 by World Book Company. Copyright in Great Britain. All rights reserved

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OTIS Correlation between ashavement 55 By Arthur S. Otis, Author of the Otis Group Intelligence Scale B CLASS INTERVAL Y-VARIABLE 넑 8 67 289 36 9 0/ 2 0 34 3 77 9 10 91 196 29 20 55 ε 6 169 39 S 98 81 6 144 11 2 11 4 9 0 100 9 9 81 6 98 5 4 06 63 6 01 40 30 49 3 (V) N 200 4 47 72 91 36 ىد 200 52 (∞) and \mathcal{L} 128 98 9 16 90 61 76 79 6 22 18 0 0 001 OT CLASS INTERVAL X-VARIABLE FX XsEX χ XXFX 88 PN bxc Ma To find ox FY Y YFY Y2 Y2FY Txy C 5 Correlation Formula E algebra marke Gx 10 4 4 CU 7 o o Œ ယ ഗ 0 9 ∞ 8 2\(C-H2+N)(F-J2+N) A-B((C+F-G)-2HJ÷N J 40 9 0 ه 0 36 49 22 16 23 22 81 g 49 36 25 16 Q÷N 9 4 9 To find 44 5 99 24 50 2 5 Gy 9 2HJ-Y-HJ÷N e g.N TOHE M.V.x BDD (y) ਨ_{xy}= HU To find Mx CALCULATION M_x 360 440 550 588 4 == 4 4 10 To find PE., KEN X H H H N C-H-N h k-N .260 J²÷N M÷S To find My P.E.r 1096.6 044 B Published by World Book Company, Yonkers-on-Hudson, New York, and 2126 Prairie Avenue, Chicago. Copyright 1922 by World Book Company. Copyright in Great Britain. All rights reserved

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OTIS Correlation between 56 By Arthur S. Otis, Ph.D. Author of the Otis Group Intelligence Scale B CLASS INTERVAL Y-VARIABLE 8 6 V2 V2FV 님 75 8 324 67 289 9 36 256 225 52 2 81 84 9[6,0 196 98 6 81 3 169 6 84 21 ىر 144 7 b 01 01 2 121 51 74 100 5 01 0/ 30 81 11 44 2 64 S 9 Sh 6 3 2 49 3 8 33 36 91 8 108 E 2 56 50 91 25 2 ∞) and + 36144 9 ک 16 112 8 67 9 72 79 8 18 6 15 0 0 001 OI zX XXXX X-VARIABLE FX XzEX PÜ 南 하 エイ = fxg find Correlation Formula Gx 10 Y YFY Y2 Y2FY 4 4 ∞ 9 G S 2 ω G 9 9 7 7 8 Š 2\(C-H2+\N)(F-J2+\N) (C+F-G)-2HJ÷N U 36 62 8 49 36 16 49 16 Q÷N 9 4 9 To find 441 56 w 60 el Qy 9 2HJ:N HH d HCI 0 A-B(82.2 HU B (F) C To find Mx CALCULATION Fxy= 8.044 037 94 725 Mx To find PE X KEN H H-N h k:N C-H²-N 000 n+m \PQ 工 \bigcirc To find 2 m X Copyright 1922 by World Book Company. Published by World Book Company, Yonkers-on-Hudson, New York, and 2126 Prairie Avenue, Chicago. Copyright in Great Britain.

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OTIS CORRELATION CHART Correlation between By Arthur S. Otis, Ph.D. Author of the Otis Group Intelligence Scale B V²FV 넑 19 9[Đ ع カな ىو ىھ (J) (∞) and 61 OT CLASS WTERVAL X-VARIABLE FX P÷N bxc $\overline{\mathsf{G}}$ 다 トイ find Gx \prec G ယ N ယ G ထ ∞ X 2\(C-H2+N)(F-J2+N) YFY Y2 Y2FY U S F find W Qy 2HJ-W HUN I HCI 8.2 M To find Mx \ (3 .67Z To find PE KEN h k-N CH-N .07 H²·N YPQ त find M . 0 My B 丙 Copyright in Great Britain. Published by World Book Company, Yonkers-on-Hudson All rights reserved

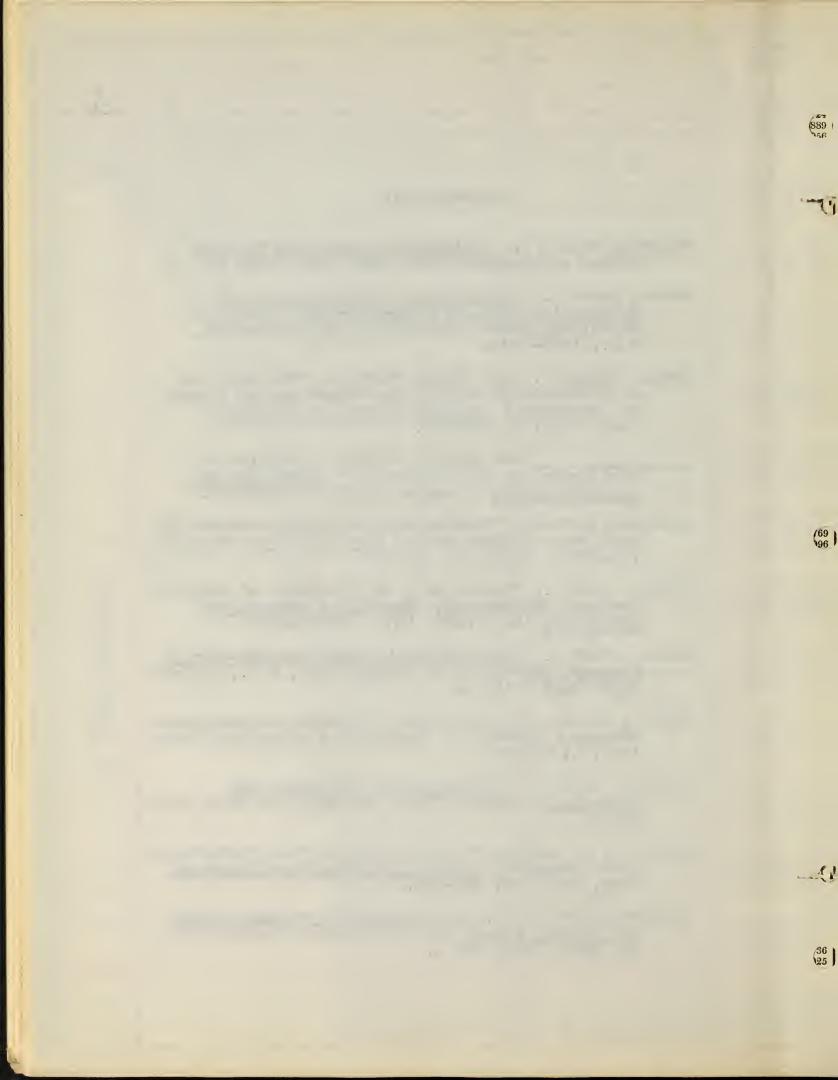
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OTIS CORRELATION CHART Correlation between 2 58 By Arthur S. Otis, Ph.D. Author of the Otis Group Intelligence Scale B CLASS INTERVAL VARIABLE 98-104 47-153 33-139 40-146 2 0 V² V²FV FV 걍 8 ₽9 324 67 289 98 9 256 52 5 9[196 60 68 6 ε 17 1 169 ζ, 2 6 63 E/ 65 25 w 20 w 11 S 121 01 100 100 6 0 81 0 128 0 2 0/ S 49 2 18 2 49 6 pusps(x) and 9 35 5 36 91 36 48 05 2 25 25 87 0 16 76 0 36 050 9 9 46 67 TH 8 79 9 21 18 6 9 0 1001 OI Xz CLASS INTERVAL X-VARIABLE FX XXXX 0 0 6 PN Lx.A トイ find Correlation Formula Gx 10 ∞ တ Ġ 4 ယ ယ 4 G 9 9 \prec 8 Q X 2\(C-H2+N)(F-J2+N) YFY U (C+F-G)-2HJ÷N $\mathcal{C}_{\mathcal{S}}$ بر 0 12 42 81 2 49 36 25 16 16 25 36 49 100 **Y2 Y2FY** 9 4 9 To find 50 84 20 36 4 99 -6 Gy 9 2HJ: HJ÷N I HCI 0 69. H U B C To find Mx = fxy 301.6M 115 100 To find PE. h k÷N C-H-N .07 不是 工 님 긔 P.E.r find 0 288 Z

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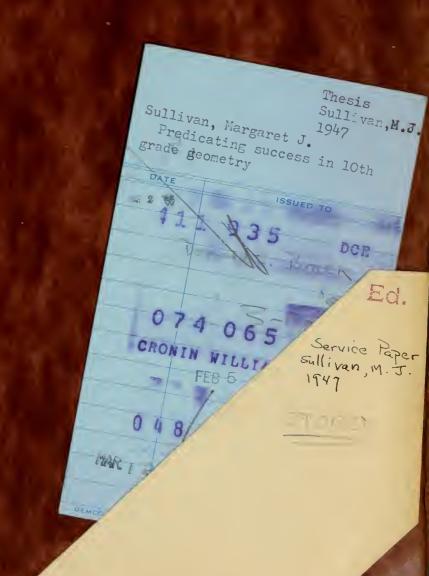
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